(12) UK Patent Application (19) GB (11) 2 324 942 (13) A

(43) Date of A Publication 04.11.1998

(21) Application No 9807718.3

(22) Date of Filing 09.04.1998

(30) Priority Data
(31) 08850337 (32) 02.05.1997 (33) US

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(51) INT CL[6]
G06F 3/153

(52) UK CL (Edition P)
H4T TBLA

(56) Documents Cited
Microsoft (R) File Manager Version 4, 1981-1996, Microsoft Corp

(58) Field of Search
UK CL (Edition P) H4T TBAX TBLA TBLX
INT CL[6] G06F 3/00 3/037 3/153
ONLINE: WPI, INTERNET

(54) Abstract Title
HIERARCHICAL NODE STRUCTURE

(57) The present invention discloses a method and apparatus for displaying a visual hierarchy of nodes. A top level node in the hierarchy is displayed as a window and lower level nodes are displayed within an area of the top level node. Lower level nodes are either expanded or unexpanded. Unexpanded lower level nodes are displayed in one area and expanded lower level nodes are displayed in another area. The unexpanded nodes conceal their contents and the expanded nodes disclose their contents, so that a visual hierarchy of nodes can be displayed a single display screen. The expanded nodes can contain several layers of lower level nodes that are visually formatted like the window.

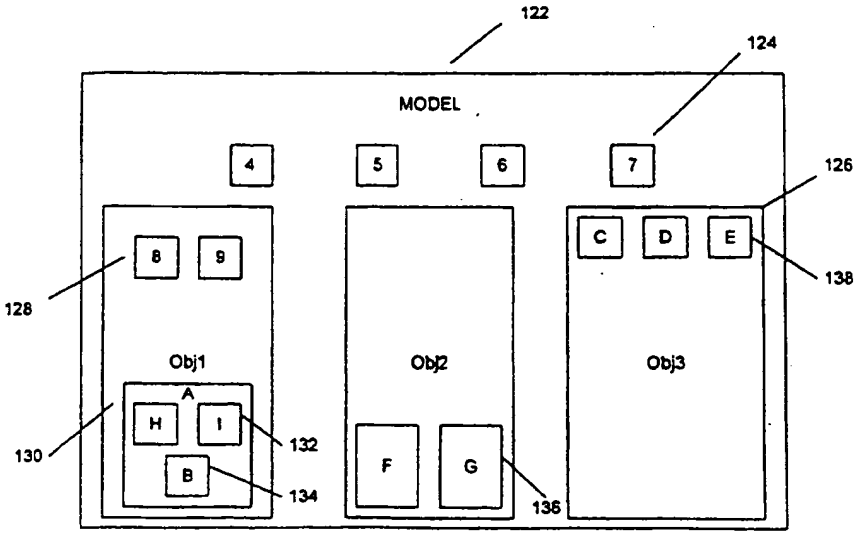

FIG. 2

GB 2 324 942 A

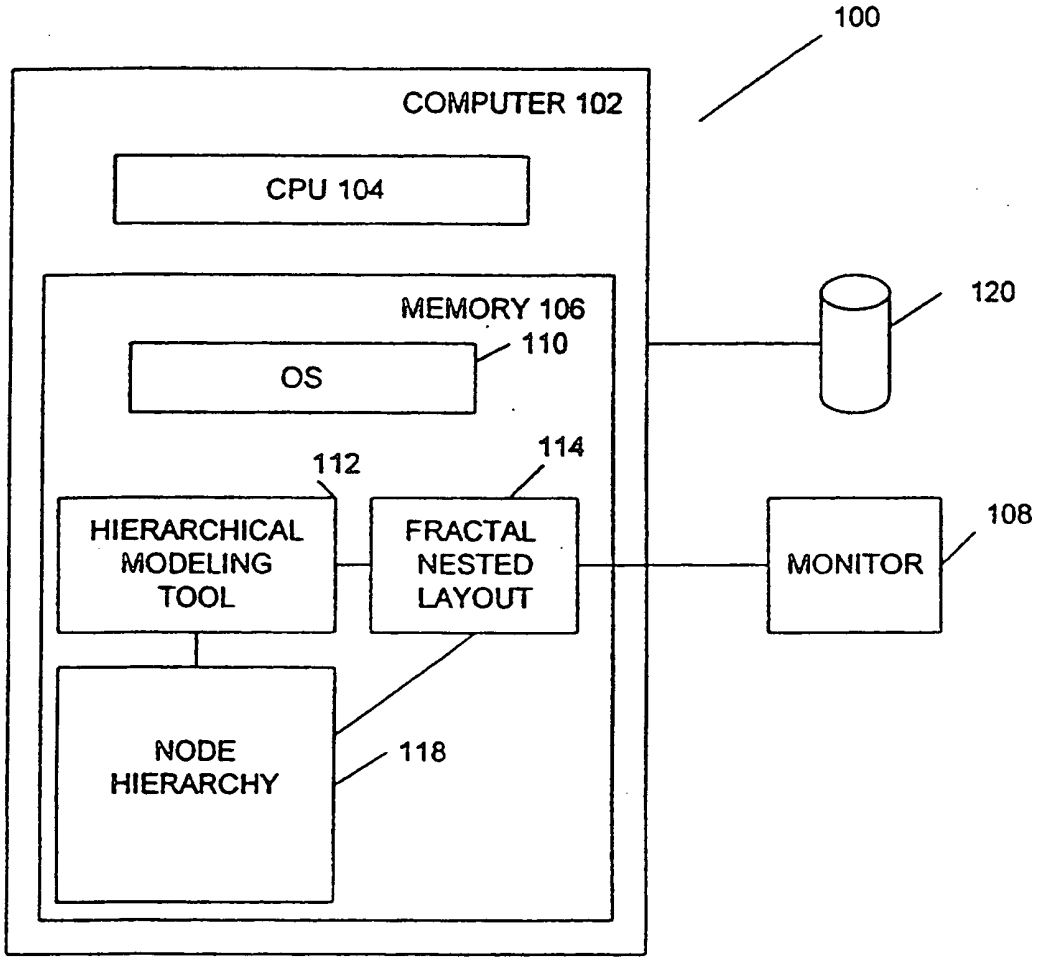
100
COMPUTER 102
CPU 104
MEMORY 106
110
OS
120
112
114
HIERARCHICAL MODELING TOOL
FRACTAL NESTED LAYOUT
MONITOR
108
NODE HIERARCHY
118

FIG. 1

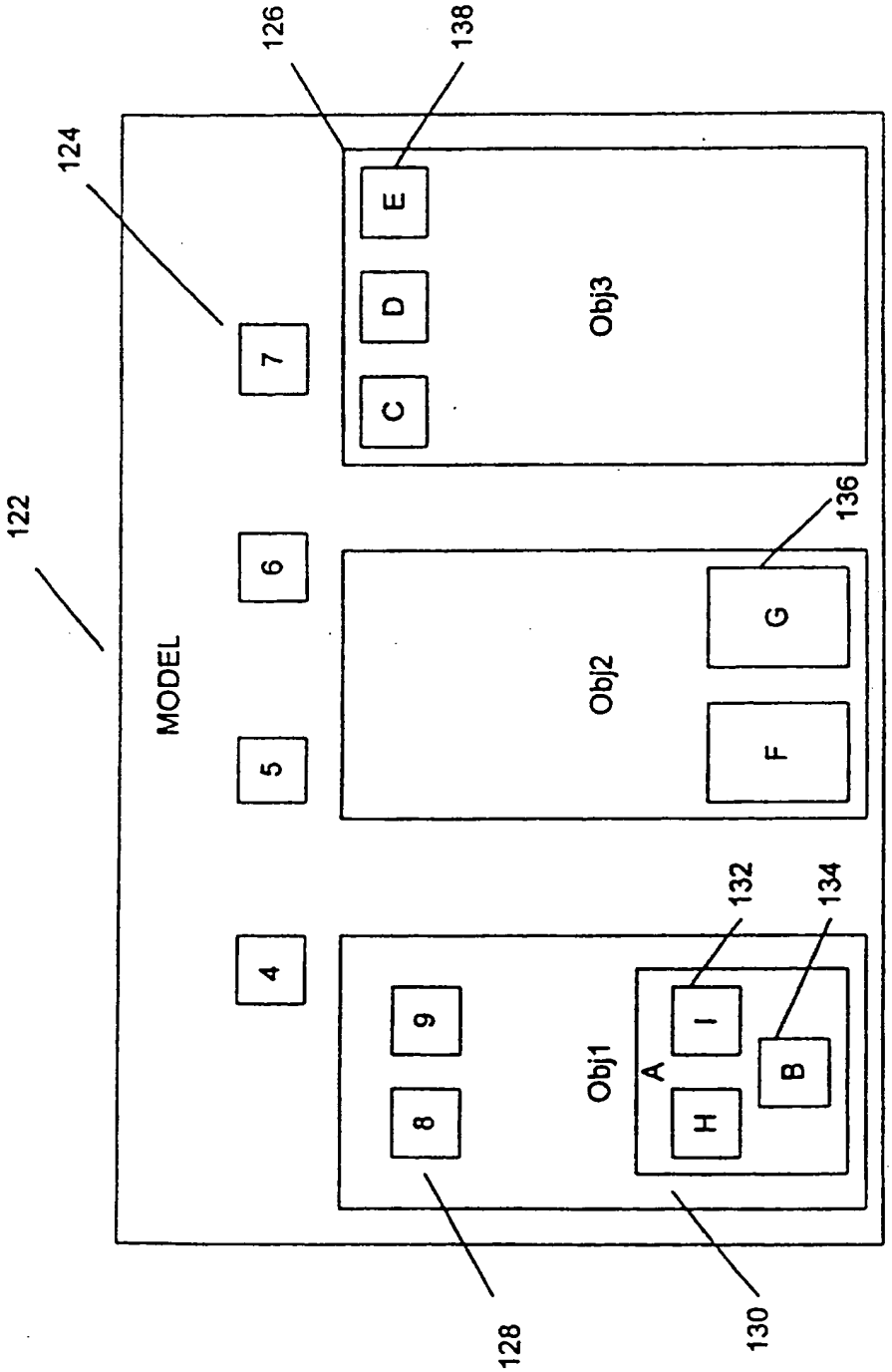
122
MODEL
124
126
138
Obj3
E
D
C
7
6
5
4
Obj2
G
F
136
Obj1
A
I
H
B
132
134
9
8
128
130

FIG. 2

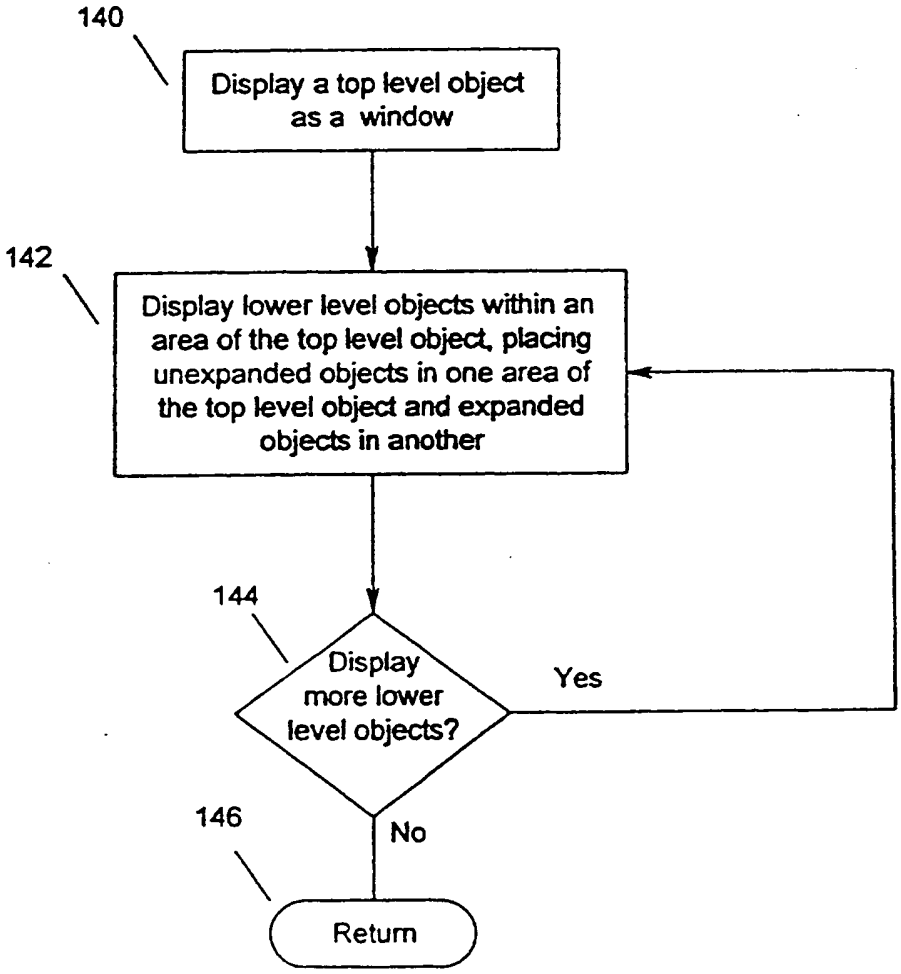
140
Display a top level object as a window
142
Display lower level objects within an area of the top level object, placing unexpanded objects in one area of the top level object and expanded objects in another
144
Display more lower level objects?
Yes
No
146
Return

FIG. 3

HIERARCHICAL NODE STRUCTURE

This invention relates generally to hierarchical systems, and in particular to a fractal nested layout for hierarchical systems.

Computer systems frequently organize data as hierarchical information structures. An example is a directory of files provided by a typical operating system. It usually contains a root directory, which consists of files and sub-directories. Each sub-directory also contains files and lower-level sub-directories. To aid a user in navigating between files and sub-directories, hierarchical structures are represented graphically as trees.

Similarly, object-oriented programming environments represent hierarchical data in a tree-like manner. In the case of a large hierarchy, this graphical representation occupies an area larger than can be displayed on most monitors. To navigate between objects, users must scroll up and down through several windows worth of data. Because each window shows only a portion of the tree, users may become confused about how a specific portion relates to the total hierarchical structure.

Thus, there is a need in the art for a graphical representation that displays a total hierarchical structure in a compact display area of a monitor.

To overcome the limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a method, apparatus, and article of manufacture for a fractal nested layout in a hierarchical system.

The present invention displays a visual hierarchy of nodes on a monitor connected to a computer. The present invention comprises the steps or elements of displaying a top level node in the hierarchy as a window on the monitor and displaying several lower level nodes within an area of the top level node. Lower level nodes are either expanded or unexpanded. The unexpanded lower level nodes are displayed in one area and the expanded lower level nodes are displayed in another area. The unexpanded nodes conceal their contents and the expanded node disclose their contents. The expanded nodes can contain several layers of lower level nodes that are visually formatted like the window.

The present invention is also director to a program storage medium, readable by a computer, the medium tangibly embodying one or more programs of instructions executable by the computer to perform the method according to the appended claims.

Various advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention and its advantages, reference should be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there is illustrated and described specific examples in accordance with the invention.

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

FIG. 1 illustrates an exemplary computer system that could be used to implement the present invention;

FIG. 2 is a block diagram that illustrates the display of a fractal nested layout according to the present invention; and

FIG. 3 is a flowchart illustrating the operation of the present invention.

The present invention comprises a hierarchical tool for displaying hierarchical information structures on a single display screen. More specifically, this hierarchical tool provides a fractal nested layout for displaying a hierarchical decomposition of a hierarchical model, wherein the hierarchy information is displayed on a monitor attached to a computer in a new, visually intuitive, manner. In the present invention, the hierarchy is comprised of a plurality of levels, wherein each level includes a set of nodes, and each node may contain a plurality of subnodes. Each subnode itself may contain a plurality of levels, wherein each of the levels may contain a plurality of subnodes. Examples of nodes include objects, folders, classes, packages, containers, archives, compressed/zip files, windows, lists, tables, notebooks, dialogs, groups, collections, indices, matrices, states, and diagrams.

A node is displayed either in an unexpanded or expanded manner. An unexpanded node hides its contents; an expanded node shows its contents,

which are its subnodes. The subnodes of an expanded node may themselves be displayed in an unexpanded or expanded manner, as desired, on an individual basis. Alternatively, a node can be displayed in another format, such as a window, list or outline embedded in the expanded hierarchy. The user may zoom and fan the hierarchy. As subnodes are expanded, they themselves become nodes and thus show their contents as subnodes. In this manner, the user may drill down through the one or more levels at a time, until the lowest possible level in the hierarchy is itself displayed.

Nodes may also be links to other nodes. In the linked case, the linked nodes are followed. Any loops (expanding the same node twice) may be terminated by not expanding the node. This option may be exercised by the user or by a pre- determined configuration.

Incidentally, nodes need not be homogenous in their representation. For instance, it is possible to mix objects and folders in a single hierarchy.

FIG. 1 illustrates an exemplary computer system 100 that could be used to implement the present invention. The computer 102 comprises a processor 104 and random access memory (RAM) 106. The computer 102 may be coupled to other devices, such as a monitor 108, a keyboard, a mouse device, a printer, etc. Of course, those skilled in the art will recognize that any combination of the above components, or any number of different components, peripherals, and other devices, may be used with the computer 102.

Generally, the computer 102 operates under the control of an operating system 110 stored in the memory 106. The present invention is preferably implemented using one or more data structures and computer programs operating under the control of the operating system 110. More specifically, the present invention comprises a hierarchical modeling tool 112 which operates under the control of the operating system 110. This hierarchical modeling tool generates a fractal nested layout 114 that includes a node hierarchy 118.

In the preferred embodiment, the operating system 110, the hierarchical modeling tool 112, the fractal nested layout 114, and the node hierarchy 118 are tangibly embodied in a computer-readable medium, e.g., random access memory 106 or data storage device 120, which could

include one or more fixed or removable data storage devices, such as a removable cartridge drive, floppy disc drive, hard drive, CD-ROM drive, tape drive, etc. Further, the operating system 110 and the hierarchical modeling tool 112 are both comprised of instructions which, when read and executed by the computer 102, causes the computer 102 to perform the steps necessary to implement and/or use the present invention. Similarly, the fractal nested layout 114, and node hierarchy 118 are all comprised of data which are used by or generated by the hierarchical modeling tool 112 to accomplish the present invention. Of course, those skilled in the art will recognize many modifications may be made to this configuration without departing from the scope of the present invention.

FIG. 2 is a block diagram that illustrates the display of a fractal nested layout 114 according to the present invention. The data displayed on the monitor 108 attached to the computer 100 is described as a fractal nested layout 114 because of the regularity of the layout 114 at each level of the hierarchy. Each level of the layout is divided into two sections, an unexpanded node section and an expanded node section. Expanded nodes are divided into two sections, unexpanded and expanded. The unexpanded and expanded regions have the same spatial position at each level of the hierarchy. This provides the visual regularity of the layout 114 and enables the intuitive understanding of the hierarchy. For example, the unexpanded region could be the top half of each expanded node, and the expanded region could be the bottom half of each expanded node. The proportion between the expanded and unexpanded regions do not have to remain rigidly fixed so long as the relative positions of the two regions are consistently maintained.

In the example of FIG. 2, the object model 122 contains four unexpanded nodes (4 , 5 , 6 , and 7) 124, and three expanded nodes (Obj1 , Obj2 , Obj3) 126. The top half of model 122 shows the unexpanded nodes 124 as opaque black boxes, visually enhancing the effect of the unexpanded aspect. The depth of an unexpanded node could be shown to indicate the number of levels graphically with color, shading or with a number.

The bottom half of the model shows the contents of the three expanded nodes 126. The expanded nodes 126 are shown here as outlined boxes, visually enhancing the expanded aspect. Graphical icons could also be used to visually enhance the aspects of expansion and unexpansion.

Obj1 contains two unexpanded subnodes (8 , 9) 128 and one expanded subnode (A) 130, which further contains two unexpanded subnodes (H , I) 132 and one expanded subnode (B) 134 which contains zero subnodes. Obj2 contains zero unexpanded subnodes and two expanded subnodes (F , G) 136, each of which contain zero subnodes. Obj3 contains three unexpanded subnodes (C , D , E) 138 and zero expanded subnodes.

As described above, the hierarchy is comprised of a plurality of levels, wherein each level includes a set of nodes, and each node may contain a plurality of subnodes. Each subnode itself may contain a plurality of levels, wherein each of the levels may contain a plurality of subnodes. As subnodes are expanded, they themselves become nodes and thus show their contents as subnodes. In this manner, the user may drill down through the plurality of levels to display more information concerning the hierarchy, until the lowest possible level in the hierarchy is itself displayed.

FIG. 3 is a flowchart illustrating the operation of the present invention.

Block 140 represents the computer 100 displaying a top level object as a window on the monitor 108 attached to the computer 100.

Block 142 represents the computer 100 displaying lower level objects within an area of the top level object. Lower level objects may include both expanded and unexpanded objects, wherein expanded objects disclose their contents and unexpanded objects conceal their contents. Similarly, an expanded object s lower level objects can be unexpanded or expanded individually.

Block 144 is a decision block that represents the computer 100 determining whether other lower levels of objects should be displayed. If the computer detects the maximum depth, then the expansion display is terminated. The expanded objects can contain a plurality of levels, each containing one or more objects, that the computer 100 visually formats like the model 122.

If additional lower levels of objects are to be displayed, control returns to Block 142; otherwise, if no lower levels of objects are to be displayed or no lower levels exist, control is transferred to Block 146

because a completed fractal nested layout has been achieved. The transition from Block 144 to Block 142 is a function call which is returned from when Block 146 is reached.

The present invention discloses a method, apparatus, and article of manufacture for a fractal nested layout in an hierarchical system. The system includes unexpanded or expanded nodes that represent a hierarchical information structure. If a preferred depth is reached, the expansion display may be optionally terminated.

The foregoing description of the preferred embodiment of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto.

CLAIMS

1. A method for displaying a visual hierarchy of nodes on a monitor connected to a computer, comprising the steps of:

(a) displaying a top level node in the hierarchy as a window on the monitor; and

(b) displaying a plurality of lower level nodes within an area of the top level node, wherein the lower level nodes comprise a plurality of levels within the visual hierarchy, so that a plurality of unexpanded lower level nodes are in a first area and a plurality of expanded lower level nodes are in a second area, when the unexpanded lower level nodes conceal their contents and the expanded lower level nodes disclose their contents.

2. The method of claim 1, wherein the expanded lower level nodes are visually formatted like the top level node, when the unexpanded lower level nodes are in a first area and the expanded lower level nodes are in a second area.

3. The method of claim 1 or claim 2, wherein the visual hierarchy of nodes is a consistent display of the top and lower level nodes.

4. The method of claim 1 or claim 2, comprising the further step of selectively expanding and unexpanding the lower level nodes.

5. The method of any preceding claim, wherein the nodes may represent objects, folders, classes, packages, containers, archives, compressed files, windows, lists, tables, notebooks, dialogs, groups, collection, indices, matrices, states, and diagrams.

6. The method of any preceding claim, wherein the nodes are heterogeneous in their representation.

7. The method of claim 1, wherein the nodes in a first hierarchy may be linked to nodes in a second hierarchy.

8. A computerized apparatus for displaying a visual hierarchy of nodes, comprising:

(a) means, performed by the computer, for displaying a top level node in the hierarchy as a window on the monitor;

(b) means, performed by the computer, for displaying a plurality of lower level nodes within an area of the top level node so that a plurality of unexpanded lower level nodes are in a first area and a plurality of expanded lower level nodes are in a second area, unexpanded nodes being nodes that conceal their contents and expanded nodes being nodes that disclose their contents.

9. The apparatus of claim 8, wherein the expanded nodes are visually formatted like the top level node, having the unexpanded nodes in a first area and the expanded nodes in a second area.

10. The apparatus of claim 8, wherein the visual hierarchy of nodes is a consistent display of top and lower level nodes.

11. The apparatus of claim 8, comprising the further step of selectively expanding and unexpanding nodes.

12. The apparatus of claim 8, wherein the nodes may represent objects, folders, classes, packages, containers, archives, compressed files, windows, lists, tables, notebooks, dialogs, groups, collection, indices, matrices, states, and diagrams.

13. The apparatus of claim 8, wherein the nodes are heterogeneous in their representation.

14. The apparatus of claim 8, wherein the nodes in a first hierarchy may be linked to nodes in a second hierarchy.

The Patent Office

9

Application No: GB 9807718.3 **Examiner:** R F King
Claims searched: All **Date of search:** 23 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4T[TBAX, TBLA, TBLX]

Int Cl (Ed.6): G06F 3/00, 3/037, 3/153

Other: ONLINE: WPI, INTERNET

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	Microsoft (R) File Manager Version 4, 1981-1996, Microsoft Corp. See 'screen dump' of 'File Manager' display of multi level hierarchical tree structure, with expanded nodes always above and to left of unexpanded nodes, at all accessed levels.	1 and 8 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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